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A5T

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(54) Improvements in or relating to breathing and resuscitation apparatus

(57) A resuscitation apparatus is disclosed for forcing air from a resilient bag 14 to a face mask via a valve 10.

The valve 10 includes a diaphragm 22 having an aperture with a one-way valve 26. As the bag 14 is squeezed the diaphragm 22 moves to the left and the valve 26 opens so that air is forced to the face mask. Upon release of the bag, valve 26 closes and valves 36 open so that the bag can inflate with fresh air. The diaphragm is biased to the right so that, should the patient recover, the patient can freely inhale and exhale fresh air via the ports 32.

Other arrangements of the valves are disclosed.

There is also disclosed a pipe connection, for example for connecting a pipe in the socket of a face mask. The pipe is tapered and fits a complementary taper of the socket. The pipe is provided with fingers which engage a shoulder of the socket. The fingers are deformable so that they can be forced past the shoulder upon mating of the tapers and are sufficiently rigid to prevent the connection working loose.

FIG. 1.

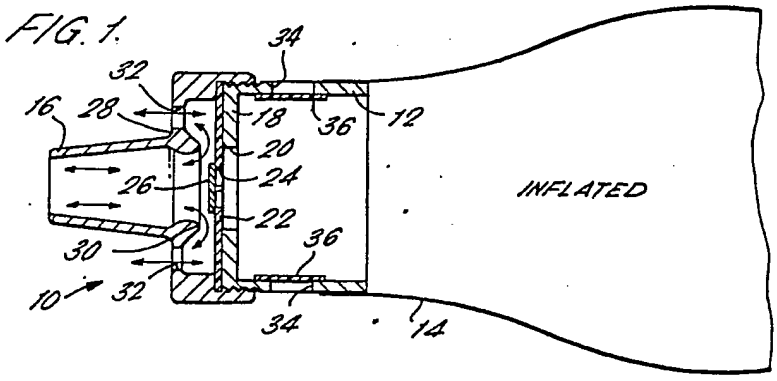

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FIG. 1.

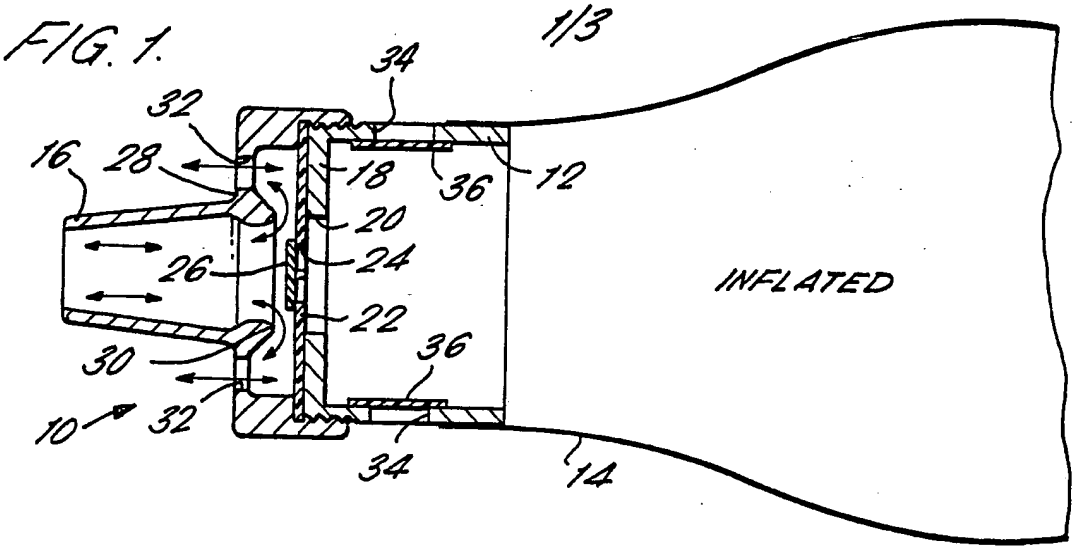


FIG. 2.

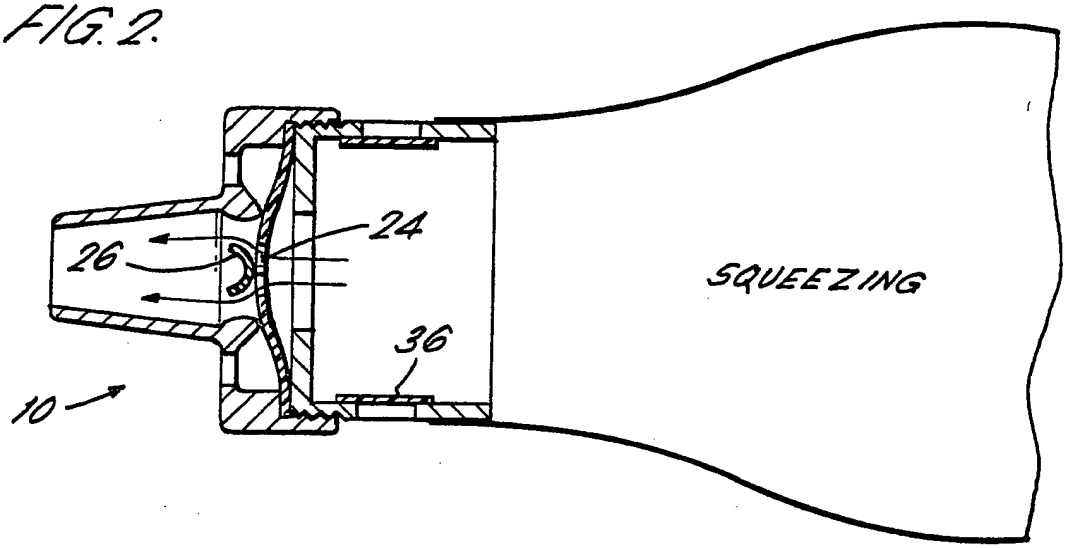


FIG. 3.

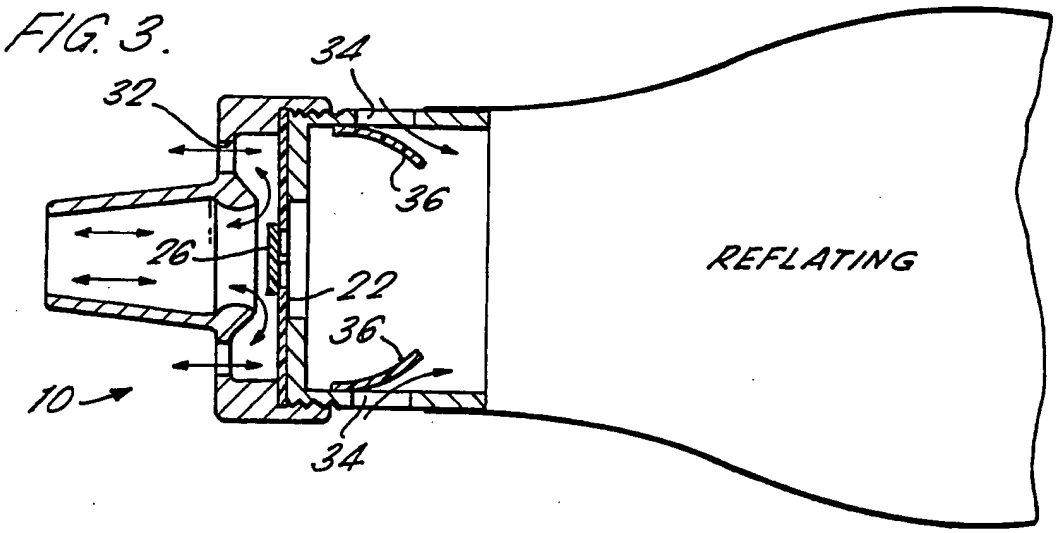


FIG. 4.

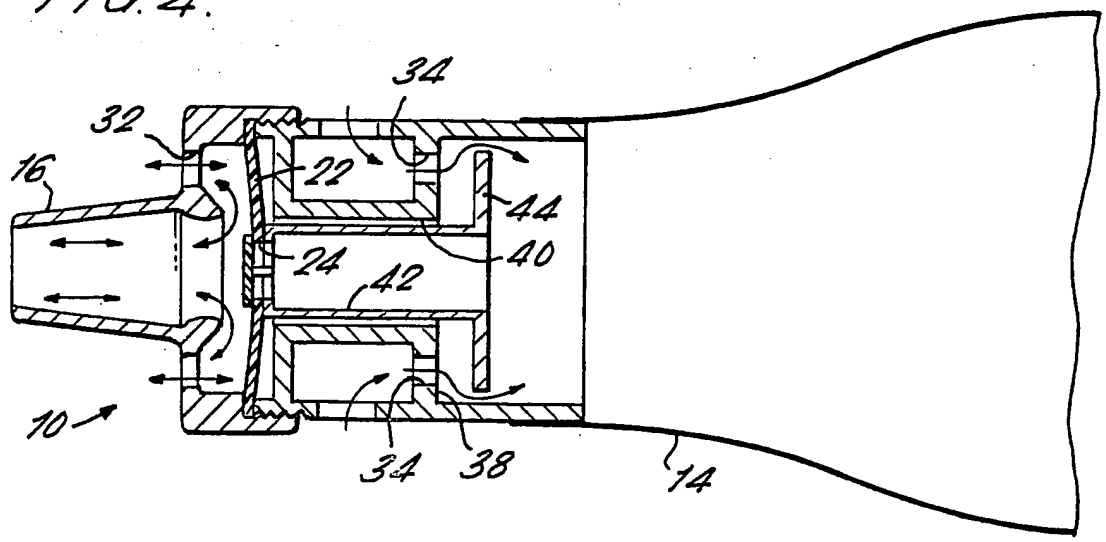


FIG. 5.

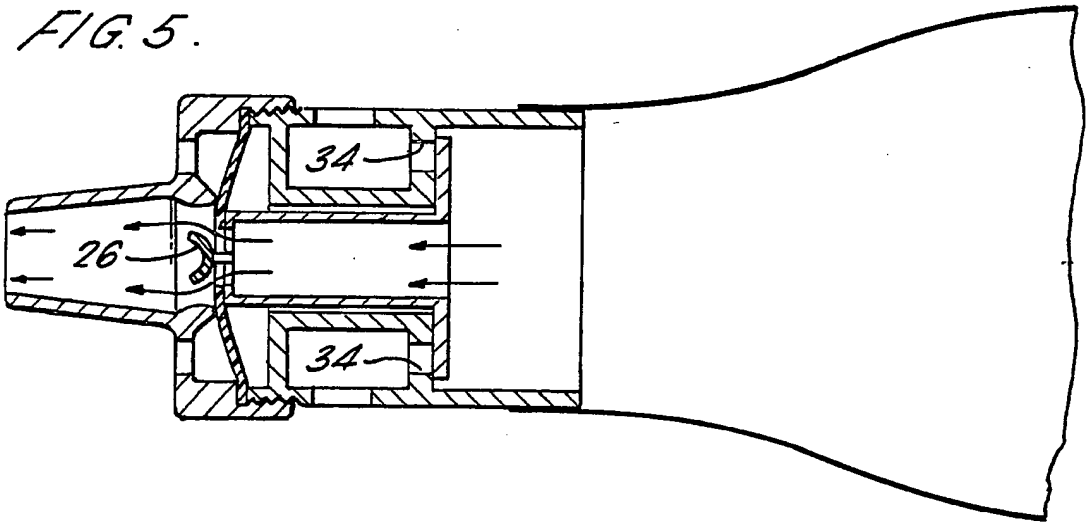
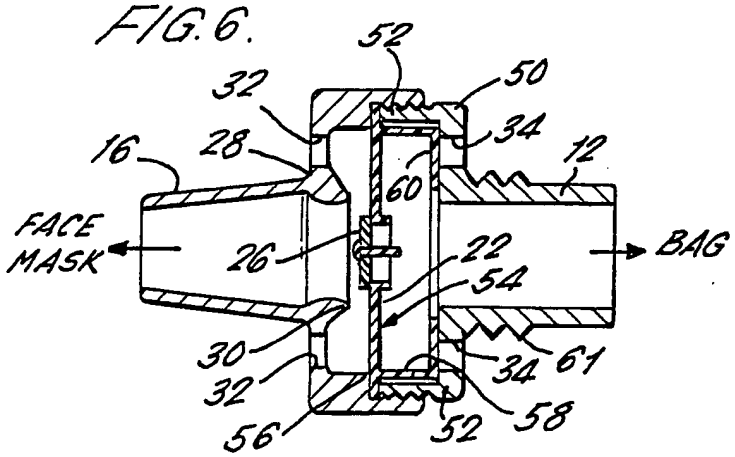


FIG. 6.



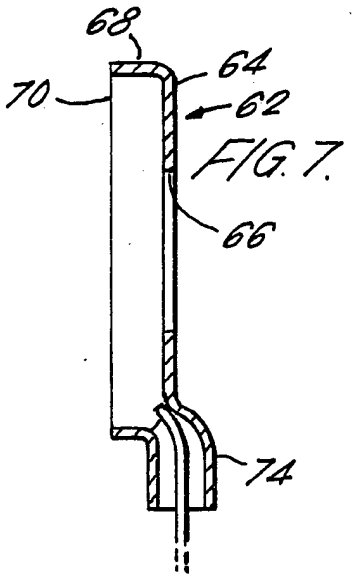


FIG. 7.

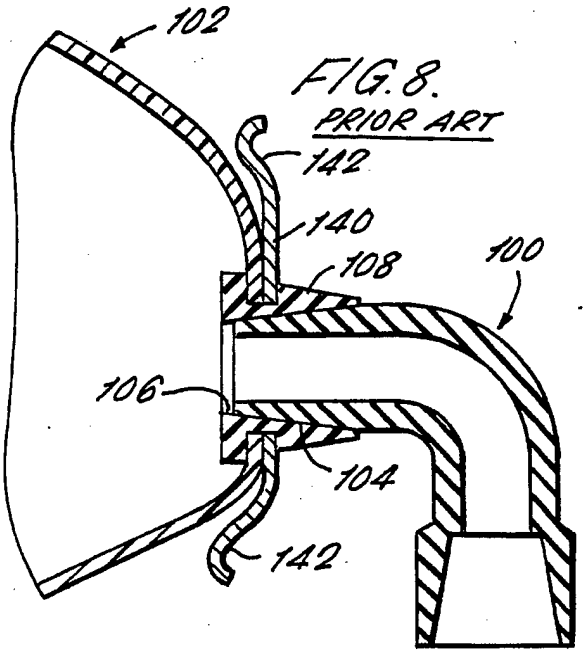


FIG. 8.
PRIOR ART

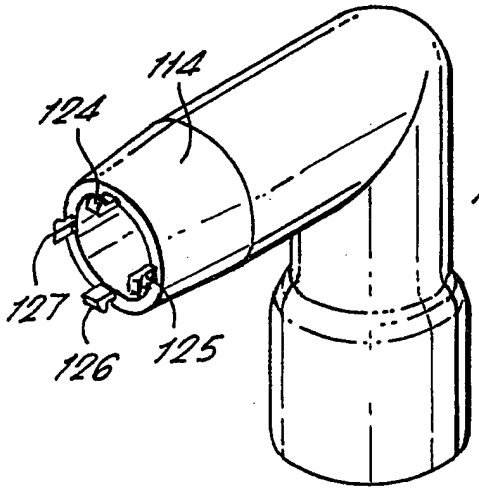


FIG. 9.

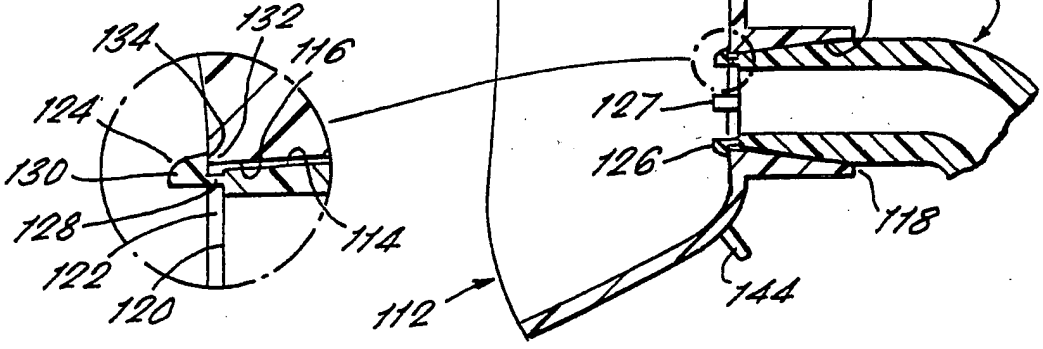


FIG. 10.

SPECIFICATION

Improvements in or relating to breathing and resuscitation apparatus

A first aspect of this invention relates to resuscitation apparatus of the type hereby defined as comprising a non-rebreathing valve assembly connected between a face mask and a squeezable resilient bag, said bag being for forcing air through the non-rebreathing valve assembly into the face mask, the non-rebreathing valve assembly comprising a first valve which opens to permit air to be drawn from the atmosphere into the bag, a second valve which opens to permit air to be forced from the bag to the face mask, and a third valve which opens to permit a patient to exhale air to the atmosphere *via* the face mask, but which closes when the bag is squeezed.

In use, the mask is held against the face of a person in need of resuscitation. The bag is squeezed, whereupon the second valve opens and air is forced into the patients's lungs. When the bag is released, the second valve closes and the first and third valves open, whereupon the bag inflates with fresh air through the first valve, and the patient can exhale air through the third valve.

An example of such apparatus is described in Patent Specification GB 1238649. The first and third valves are formed by a member freely slidable in a tube provided with two sets of ports, one set for the first valve and the other set for the third valve. A disadvantage of such apparatus is that when used with the tube orientated other than in a horizontal direction, the weight of the slidable member effects its performance. If oriented vertically such that the third valve is normally closed, the patient can exhale causing the slidable member to lift and open the third valve; however, if the patient recovers and tries to inhale, the third valve will remain closed and prevent air being inhaled other than any which can leak past the valve or the face mask. If the slidable member is spring-biassed so that the first and third valves are normally open in order to overcome this problem, then the operation of the slidable member becomes more sluggish when the tube is horizontally oriented; as a result, when the bag is squeezed, a significant amount of air is lost to the atmosphere through the first valve before the slidable member moves to close that valve, and thus less air can be forced into the patient's lungs. Another disadvantage of the apparatus described in GB 1238649 is that the slidable member and tube must be machined very accurately in order to achieve satisfactory performance.

In accordance with the first aspect of the present invention, an improvement is made of resuscitation apparatus of the type hereinbefore defined, in that the third valve comprises a diaphragm movable between a first position in which a passageway to one side of the diaphragm from the face mask to the atmosphere is open and a second position in which said passageway is caused by the diaphragm to be closed, the other side of the diaphragm being subjected to the pressure in the bag to urge the diaphragm to the second position when the bag is squeezed, and biasing means being provided arranged such that when the diaphragm is in the first position, the biasing means holds the diaphragm in that position, whatever the orientation of the non-rebreathing valve, so that a patient can freely inhale and exhale atmospheric air *via* the face mask and said passageway.

The diaphragm is preferably of lightweight construction. The self-resilience of the diaphragm need not be such as to move the diaphragm from the second position to the first position, since such movement can be caused by the patient exhaling. However, once the diaphragm has been moved to the first position, the self-resilience of the diaphragm holds it there (until the bag is squeezed again) to permit the patient to inhale.

Specific embodiments of the first aspect of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a non-rebreathing valve and part of a bag used in the present invention, showing the positions of the valves when the bag is inflated;

Figure 2 is similar to Figure 1, but showing the positions of the valves when the bag is being squeezed;

Figure 3 is similar to Figure 1, but showing the positions of the valves when the bag is reflating;

Figures 4 and*5* are schematic illustrations of a modified non-rebreathing valve showing the positions of the valves when the bag is reflating and being squeezed, respectively;

Figure 6 is a schematic illustration of a further modified non-rebreathing valve showing the valve positions when the bag is relaxed;

Figure 7 is a sectioned side view of an adaptor unit for use with the valve shown in Figure 6.

Referring to Figures 1 to 3, a non-rebreathing valve assembly 10 has a tubular portion 12 onto which is sealed a resilient self-inflating bag 14 of the type described in Patent Specification GB 1238649. The valve assembly 10 also has a further tubular portion 16, which may taper, and onto which is fitted a tube leading to a face mask.

The tubular portions 12, 16 are axially aligned and spaced apart within a housing 18. A resilient diaphragm 22 extends across the housing between the tubular portions 12, 16. The periphery of the diaphragm 22 is held by and sealed to the housing 18, conveniently by being nipped between two screw-threaded parts 20, 21 of the housing. At least one aperture 24 is formed in the centre of the diaphragm, which aperture is normally closed by a one-way valve 26, which may be a resilient flap valve or a spring-loaded valve, as described in Patent Specification GB 1238649. The valve 26 permits air to flow from the bag 14 to the tubular portion 16, when the pressure in the bag is higher than that in the tubular portion 16, but prevents flow in the reverse direction.

The tubular portion 16 extends centrally into a transverse wall 28 of the housing part 20 spaced from the diaphragm 22 and, at the inner end of the tubular portion 16, has a raised annular portion which provides a valve seat 30 to co-operate with the

diaphragm 22. The diameter of the seat 30 is about 20mm and the spacing of the seat 30 from the diaphragm when the latter is undistorted (as shown in Figures 1 and 3) is small, for example about 1½mm. A plurality of ports 32 are formed in the transverse wall 28 around the tubular portion 16. When the diaphragm is in its undistorted position a passageway is thus formed from the tubular portion 16, between the diaphragm and the seat 30, *via* the ports 32 to the atmosphere.

The tubular portion 12 extends into a transverse wall 33 of the housing part 21, and a plurality of ports 34 are provided in the transverse wall 33, each port being provided with a one-way valve to permit air to flow through the ports 34 only when the pressure in the tubular portion 12 is sub-atmospheric. The one-way valves may be provided by an annular flap valve 36, the periphery of which is nipped between the wall 33 and one end of a sleeve 37. The other end of the sleeve 37 is flanged and nipped between the screw-threaded housing parts 20, 21.

In operation, the face mask is held against the patient's face and the bag is squeezed. This causes the diaphragm to be deformed so that it seals against the valve seat 30, and the flap valve 26 opens, as shown in Figure 2, so that air is forced from the bag into the patient's lungs.

When the bag is released, the flap valve 26 closes and the diaphragm 22 returns to its undistorted position, as shown in Figure 3. Thus the patient can exhale *via* the ports 32. Also the annular flap valve 34 opens and the bag reflates. Once the bag is fully inflated, as shown in Figure 1, the bag is squeezed again.

If the patient starts breathing of his own accord, then he can inhale and exhale freely *via* ports 32 except when the bag is being squeezed.

The non-rebreathing valve 10 may be modified so that the diaphragm 22, in its relaxed state, is slightly dished and will thus hold itself in either of the two positions, that is, with the passageway between the tubular portion 16 and the port 32 open or closed.

A further modification of the non-rebreathing valve is illustrated in Figure 4, in which the valve to permit the bag to reflate is provided on a separate spool-shaped insert member 40 in the housing. The insert member 40 forms with the housing 18 an annular chamber 42 which communicates freely with the atmosphere *via* ports 44 in the housing wall. A rear wall 46 of the insert member is provided with a plurality of ports 48, which are normally covered by an annular flap valve 50. The inner periphery of the flap valve is held in a radially outwardly facing groove 52 formed on the insert member 40. The insert member 40 is held in place by suitable formations on the housing 18.

In use, the annular flap valve 50 closes the ports 48 except when the bag 14 is released after having been squeezed.

The diaphragm may be made of rubber or neoprene. Alternatively, the diaphragm may be replaced by a thin sheet metal diaphragm arranged to move bodily rather than distorting, and a light spring may be used to urge the diaphragm to the position in which the patient can freely inhale and exhale. The housing parts of the valve assembly may be moulded in a plastics material such as polycarbonate.

The bag 14 is generally ellipsoidal in shape and the end of the bag opposite the valve assembly is provided with an inlet for connection to a supply of oxygen, as described in Patent Specification GB 1238650. A pressure relief valve forming a combined unit with the oxygen inlet is also included, the pressure relief valve being arranged to open if the gauge pressure in the bag 14 exceeds 70cm of water.

Referring to Figure 6, a further modified non-rebreathing valve is shown which is similar in many respects to that shown in Figure 1 to 3, and like reference numerals are used to denote like parts. However, in Figure 6, the tubular portion 12 is generally the same diameter as the tubular portion 16. The portion 12 projects from a transverse wall 50 opposite the wall 28, the outer periphery of the wall 50 having a screw threaded flange 52 which engages the screw threaded flange on the periphery of the transverse wall 28.

The transverse wall 50 is formed with a plurality of ports 34, through which air can be drawn from the atmosphere into the bag.

The pair of transverse walls 32, 50 and their peripheral flanges form a short cylindrical chamber in which a composite valve member 54 is disposed. The composite valve member 53 comprises a resilient diaphragm 22 serving the same purposes as the diaphragm 22 shown in Figures 1 to 3. The edge of the diaphragm 22 is nipped between the flange 52 and a ridge 56 formed on the transverse wall 28. A cylindrical portion 58 of the valve member 54 projects from the diaphragm 22 towards the transverse wall 50, the cylindrical portion 58 being closely embraced by the flange 52. At the transverse wall 50, the composite valve member turns inwardly to form an annular lip which covers the ports 34 to form an annular flap valve 60. The centre of the diaphragm is provided with an opening covered by a one-way valve 26 similar to that shown in Figures 1 to 3.

In the valve assembly shown in Figure 6, the one-way valve 26, diaphragm portion 22 and annular flap valve operate in a similar manner to the one-way valve 26, diaphragm 22 and the flap valves 36 shown in Figures 1 to 3.

The diaphragm portion 22, cylindrical portion 58 and annular flap valve 60 are made a singel integral member moulded from a rubber-like or resilient plastics material.

In order that the non-rebreathing valve may be used to supply bottled air or oxygen, rather than air from the atmosphere, the tubular portion 12 shown in Figure 6 is formed with a screw thread 61 which can be used to secure an adaptor unit 62 as shown in Figure 7 onto the portion 12.

The adaptor unit 62 comprises a circular plate 64 having a central hole 66 to receive the tubular portion 12 of the valve and a peripheral flange 68 the free edge of which abuts the transverse wall 50 of the valve near the periphery of the wall. A nut is then fitted to the screw thread 61 to hold the adaptor unit in place. Bottled air or oxygen is fed to the adaptor unit 62 via a fine-flexible tube 72 which verminates

within the adaptor unit 62. In order to provide a reservoir at atmosphere pressure from which air or oxygen can be drawn at high rate with little restriction, a larger bore flexible tube, about 1 to 1½ metres long, is connected at one end to short pipe stub 74 projecting from the adaptor unit 62. The other end of the large bore tube is open to atmosphere. The fine bore tube 62 passes through the large bore tube and projects from the open end thereof for connection to the air or oxygen bottle. Once the air or oxygen supply is turned on, the large bore tube fills with the gas via the adaptor unit 62. Accordingly when the bag is inflating, it draws the gas mainly from the large bore tube, rather than the fine bore tube.

The adaptor unit 62 may be secured to the non-rebreathing valve by means other than the screw thread and nut. Especially when the valve housing and adaptor unit are made of the plastic material they may be secured by a push fit which may include a snap action.

A second aspect of this invention relates to pipe connections for breathing apparatus, for example resuscitation apparatus.

Figure 8 of the accompanying drawings shows a known elbow joint 100 connected to a face mask 102. The connection is usually, as illustrated, a 1:40 push taper fit as required by British Standards Institution publication BS 38 49. The elbow has a tapered end 104 which fits into a complementary tapered socket 106 in a socket member 108 on the face mask. The tapered end and socket rely on friction to secure the joint. The elbow and socket member are made of hard rubber which deforms slightly when the joint is made to provide a joint which is sufficiently secure for most purposes. However, occasionally the joint works loose and thus the air or oxygen line to the face mask is broken, with possible very dangerous consequences. Lives have been lost due to these connections working loose.

A further problem with the known connection described above is that, since the parts are made of rubber, the parts are not suitable for sterilising in an autoclave. If made of certain plastics material the parts could be autoclaved, but then the resilience of the parts would not be sufficient for the taper fit to secure the parts firmly.

It is an object of the second aspect of the present invention to provide a pipe connection for breathing apparatus which can be made of a less resilient, autocalvable material and which provides a simply way of ensuring that the tapered joint does not become disloged accidentially, but which enables the joint to be forced apart when desired.

In accordance with the second aspect of the present invention there is provided a pipe connection between first and second parts of a breathing apparatus, the first part having an external tapered surface which tapers towards an end of the part and the second part having a complementary tapered socket which tapers away from the mouth of the socket, and into which the tapers away from the mouth of the socket, and into which the tapered surface of the first part can be fitted, the smaller end of the socket having a shoulder facing away from the mouth of the socket and the first part being provided with at least two spaced apart fingers which engage the shoulder when the tapers are mated to lock the connection, the fingers being resiliently deformable so that the fingers can be forced past the shoulder both upon mating of the tapers and when the parts are pulled apart, and the fingers being sufficiently rigid to prevent the connection working loose.

A specific embodiment of a pipe connection according to the second aspect of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 9 is a perspective view of an elbow constituting the first part of the connection; and

Figure 10 is a sectioned side view of the elbow mated with a face mask which constitutes the second part of the connection.

Referring to Figures 9 and 10, there are shown an elbow 110 and to a face mask 112, each being a single moulding of rigid plastics material. The elbow 110 has a tapered end 114 with a 1:40 taper. The face mask 112 has a complementary tapered socket 116. The end 114 of the elbow 110 is fitted to the socket 116 by insertion into the mouth 118 of the socket, and when pushed fully home the end edge 120 of the elbow stops just short of the open smaller end 122 of the socket.

Four spaced apart fingers 124 to 127 are formed on the end edge 120 of the elbow. As shown in the detail part of Figure 10, each finger comprises a relatively thin portion 128 projecting from the end edge 120 of the elbow to a thickened portion 130.

The face mask around the smaller end 122 of the socket provides a shoulder 132 which is engaged by complementary surfaces 134 of the thickened portion of each finger 124 to 127.

The thin portions 128 of the fingers permit the fingers to be distorted radially inwardly as they move pas the smaller end 122 of the socket when the tapered end of the elbow is forceably inserted or withdrawn into or from the socket. Once the tapered end of the elbow has been inserted fully into the socket, the fingers relax and move radially outwardly, and the surface 134 on the thickened portions of the fingers by engaging the shoulder 132 prevent the connection working loose.

In the known face mask 102 shown in Figure 8, the rubber socket member 108 serves also to secure to the face mask a metal ring 140 having a number of radially projecting arms 142 with hooked ends. These hooked ends serve as attachment points for elasticated bands which pass around the back of the user's head to hold the face mask in position. In the arrangement shown in Figure 10, a plurality of integrally moulded pegs project from the face mask to serve as such attachment points. Thus, whereas the known mask comprises four separate parts, the face mask shown in Figure 10 is formed by a single moulding.

CLAIMS

1. Resuscitation apparatus of the type defined, wherein the third valve comprises a diaphragm movable between a first position in which a passage-

way to one side of the diaphragm from the face mask to the atmosphere is open and a second position in which said passageway is caused by the diaphragm to be closed, the other side of the diaphragm being subjected to the pressure in the bag to urge the diaphragm to the second position when the bag is squeezed, and biasing means being provided arranged such that when the diaphragm is in the first position, the biasing means holds the diaphragm in that position, whatever the orientation of the non-rebreathing valve, so that a patient can freely inhale and exhale atmospheric air *via* the face mask and said passageway.

2. Apparatus as claimed in claim 1, wherein the diaphragm is resiliently deformable and is mounted by the periphery thereof in a housing of the non-rebreathing valve assembly, the biasing means being provided by the resilience of the diaphragm.

3. Apparatus as claimed in claim 2, wherein the first valve is provided by a resilient annular flap valve which can seal a plurality of holes in the valve housing.

4. Apparatus as claimed in claim 3, wherein the periphery of the annular flap valve is joined to the diaphragm adjacent the periphery thereof by an integral cylindrical portion.

5. Apparatus as claimed in claim 1, wherein the diaphragm is stiff and bodily moveable between the first and second positions, the biasing means comprising a spring acting on the diaphragm.

6. Apparatus as claimed in any preceding claim, wherein said passageway extends between the diaphragm and an annular valve seat, the passageway being closed by sealing contact of the diaphragm with the valve seat.

7. Apparatus as claimed in any preceding claim, wherein an aperture is formed in the diaphragm, the second valve being a non-return valve arranged to close the aperture except when the bag is squeezed.

8. Apparatus as claimed in claim 6 and 7, wherein the valve seat is arranged to contact the diaphragm around the aperture therein.

9. Apparatus as claimed in any preceding claim, wherein the diaphragm and said first valve are operably connected so that when the diaphragm is in said second position, the first valve is closed.

10. Apparatus as claimed in any preceding claim, wherein the squeezable bag is generally ellipsoidal, the non-rebreathing valve being connected to one end of the bag, and an assembly combining the functions of an oxygen inlet and a pressure relief valve being connected to the other end of the bag.

11. Resuscitation apparatus substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 3 or Figures 1 to 3 as modified by Figures 4 and 5 or Figures 6 and 7 of the accompanying drawings.

12. A pipe connection between first and second parts of a breathing apparatus, the first part having an external tapered surface which tapers towards an end of the part and the second part having a complementary tapered socket which tapers away from the mouth of the socket and into which the tapered surface of the first part can be fitted, the smaller end of the socket having a shoulder facing away from the mouth of the socket and the first part being provided with at least two spaced apart fingers which engage the shoulder when the tapers are mated to lock the connection, the fingers being deformable so that the fingers can be forced past the shoulder when both upon mating of the tapers and when the parts are pulled apart, and the fingers being sufficiently rigid to prevent the connection working loose.

13. A connection as claimed in claim 12, wherein at least three and preferably four of said fingers are provided.

14. A connection as claimed in claim 12 or 13, wherein each finger comprises a portion projecting from the end of the first part in the direction of the axis of the taper and surface extending outwardly from the projecting portion to engage the shoulder on the second part.

15. A connection as claimed in claim 14, wherein the first part is made of rigid plastics material, the fingers being integral therewith and the cross section of the axially projecting portions of the fingers being sufficiently small to permit the projecting portion to distort upon mating of the tapers and when the tapers are pulled apart.

16. A connection as claimed in any of claims 12 to 15, wherein said second part is a face mask having a face covering portion, the socket being integrally moulded with the face covering portion.

17. A pipe connection between first and second parts of a breathing apparatus, substantially as hereinbefore described with reference to and as illustrated in Figures 9 to 11 of the accompanying drawings.

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